



International Journal of Fisheries and Aquatic Studies

ISSN: 2347-5129

(ICV-Poland) Impact Value: 5.62

(GIF) Impact Factor: 0.352

IJFAS 2015; 3(2): 24-34

© 2015 IJFAS

www.fisheriesjournal.com

Received: 27-08-2015

Accepted: 28-09-2015

Sreekanth GB

ICAR-Central Coastal
Agricultural Research Institute,
Old Goa, Goa, 403402.

Manju Lekshmi N

ICAR-Central Coastal
Agricultural Research Institute,
Old Goa, Goa, 403402.

Narendra Pratap Singh

ICAR-Central Coastal
Agricultural Research Institute,
Old Goa, Goa, 403402.

Fisheries profile of Zuari estuary

Sreekanth GB, Manju Lekshmi N, Narendra Pratap Singh

Abstract

The inshore coastal waters where traditional and motorised fisheries operate contain rich fishing grounds. The gears such as shore seines and drag nets are operated from the beach, while gillnets, drift nets, traps and hooks and lines are operated from boats along the coastal waters. Estuaries are important coastal ecosystems that yield rich variety of fishes, crustaceans and molluscan resources. These ecosystems provide breeding, hiding and nursery grounds for more than 200 species of marine fishes and shellfishes. However, no extensive studies were done earlier to catalogue the fishery and species diversity in these ecosystems. The Zuari estuary, one of the major estuaries of Goa, located in the southwest coast of India connecting to the Arabian Sea through Mormugao Bay represents a very rich coastal ecosystem for fishery resources. A traditional fishery comprising of motorised and non-motorised boats operate gillnets and hook lines exist in the Zuari estuary. An effort was made in this study to catalogue the fisheries profile and fish and shellfish diversity in Zuari estuary.

Keywords: Zuari estuary, gillnet fishery, hook and line, fisheries management

Introduction

The margins of Zuari estuary have dense mangrove vegetation filled with silt, clay and detritus that has been transported by riverine influx from upper reaches. The entire mudflats along with mangrove vegetation make the region highly productive supporting large number of economically important species. This region receives the maximum precipitation during the southwest monsoon accompanied by stormy weather, while quieter conditions prevail during rest of the year. The Zuari mouth in this study is characterized by the estuarine influences of the river. Reports say that that the region is very important to a number of finfishes and shellfishes of commercial significance. These areas are utilized both as a nursery ground by marine species and as a residence for euryhaline coastal and estuarine species. Apart from these, the juveniles of many of these species are also frequently abundant in these bays and estuaries. The existence of typical tropical conditions is characterized by high temperature and longer photoperiod which is conducive to greater biological productivity. The tidal regime also results in a long flushing period and thus, there is a prevalence of greater species diversity in the estuary. Traditional fishery within this coastal zone (mouth of Zuari estuary) is considered to be an activity which will be significantly correlated to the finfish and shellfish diversity along the coastal ecosystem. The entire coastal zone has a bed of rocky patches (which makes it unsuitable for trawling) and hence the gillnet fishery represent majority of the landed catch. The region holds a medium fish landing centres like Siridao, Cakra, Odxal, Bambolim and Nauxim which lands about 1000 tonnes of fish every year (Table 1). The gillnet fishery is found to be a major subsistence activity of the traditional and motorised fishermen along these regions along the Zuari mouth with catches consisting of diverse fish and shellfish taxonomic groups. Moreover, occasional hook and line fishing and skin diving for bivalves are also included in the fishery of Zuari.

Correspondence

Sreekanth GB

ICAR-Central Coastal
Agricultural Research Institute,
Old Goa, Goa, 403402.

General fisheries profile of Zuari estuary

Particulars	Details
Fishermen families	1000
Fishermen population	3000
Average size of family	4.5
Active fishermen	500
Major occupation	Fishing
Methods of fishing	Gillnetting, Hook and line fishing and skin diving
Fishing craft types	Fibre glass (4-8 m LoA) and Wooden (2 to 5 m LoA)
Mode of operation	Manual and motorised (8.8 to 9.9 HP)
Gears used	Gillnets, seine nets, hook & lines and traps
Mesh size (mm)	30-200 (Gillnet)
Average Catch Per Unit Effort (kg/hr)	10-12
Value Per Unit Effort (Rs./hr)	500-700
Average monthly income	6000-7000
Average fish landings in an year (tonnes)	1000
Major species in fishery	Mackerel, sardines, white sardine, mullets, white baits, moustached anchovy, mullets, silver bellies, carangids, croakers, cat fish, crabs, shrimps

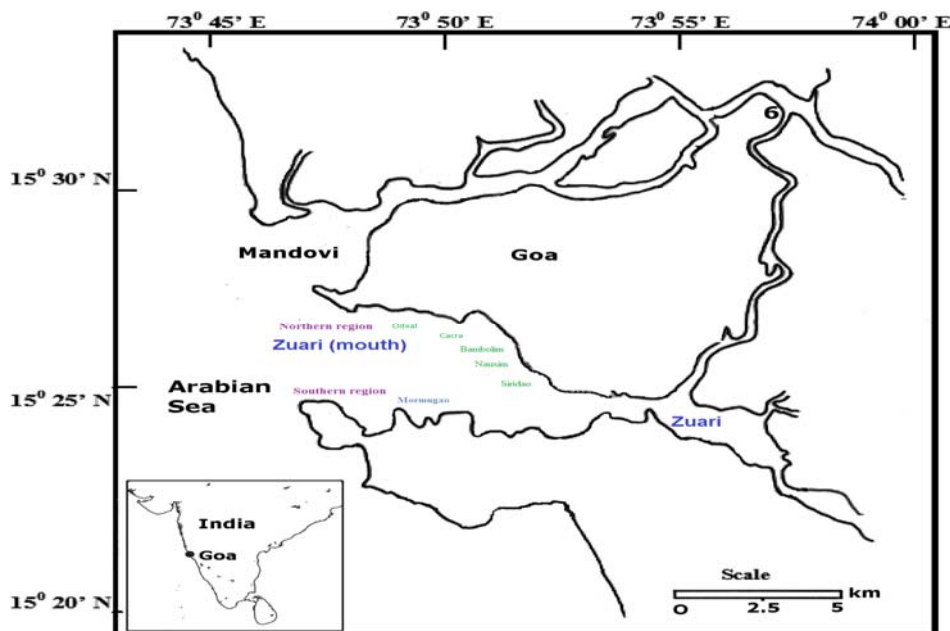
Fishing conflicts and actions

The introduction of more efficient fishing technology and the expansion of the fishery were necessary to tap the unexplored fishery potential along the Indian coast. This led to the division of two social, economic and ethnic fishing groups - one representing the artisanal or small-scale sector and the other, the mechanised fishing sector, both competing and exploiting the same resource in the inshore waters. The present study area is subjected to a relatively high mechanized fishing pressure which has resulted in changes in the major taxonomic groups and size structure of some of the dominant genera and species. The operation of illegal mechanised vessels in the coastal ecosystems is reported. This will have negative impacts on the populations of resident species, semi-resident species and migrant species in the coastal system. Moreover, there is a division in the fishing operations like the mechanised, motorised and traditional operations. The traditional and motorised fishermen are represented by the coastal communities who operate their gears from motorised (Out Board Motor (OBM) upto 10 HP) and non-motorised boats

within the 5 km stretch and the power of motor will be upto 10 HP. Moreover, they will be using vessels less than 12 m in length. However, the intrusion of mechanised vessels into the coastal zones as well as the exposure of motorised fishermen beyond 5 km have created a critical social concern in fishing operations and resulted in fishing conflicts. Similarly, there is also a conflict in the fishing fleet between the mechanised and traditional fishing sector in this estuary. However, recently the fisheries department has introduced a fisheries patrolling boat and become functional since October, 2014 which has thinned this conflict as the intrusion of mechanised vessels was reduced since then. Thus, the fisheries department has taken a very good initiative to conserve the fish diversity and preserve the traditional fishery in this estuary

In order, to state the importance of coastal ecosystem to the stakeholders, a cataloguing effort was essential along the proposed site. Hence, the present study was carried out to document the species diversity of Zuari estuarine mouth from September 2013 to March 2015.

Traditional fishery of Zuari estuary



The major fish landing sites and fishing villages in Zuari estuary



View of the traditional fish landing site in Zuari estuary (Siridao)

Fishing is found to be a major subsistence activity of the people in this region. Therefore the main settlements on the estuary are the rural communities of tribal fishermen (Gawde Tribe) which consist of mostly of Kongini speaking people. There are about 300 active fishermen operate gillnets throughout the year. Since early 1850s, the people of these communities are engaged in fishing. However, most of the people who were fishing in the estuary are moved to Portugal through Portuguese visa followed by India's independence in 1947. Motorised boats (made of FRP (4-8 m LoA) or wood (2-5 m LoA) which use an OBM are used in the gillnet fishery. Monofilament nylon bottom set gillnets are commonly used in the estuary targeting mackerel, sardines, white sardine, mullets, white baits, moustached anchovy, mullets, silver bellies, carangids, croakers, cat fish, crabs and shrimps (Table 1). The gillnets of different mesh sizes ranging from 30-200 mm are used in fishing grounds of 2 to 5 m depth. They are usually set early in the morning and hauled after two hours. Moreover, they also operate hook and lines during the pre-monsoon season (February to May). Skin diving for collection bivalves like mussels and oysters also happens during the pre-monsoon. The catches are marketed fresh in major fish markets of Goa (Panjim and Mapusa) and about of 10% catch is used for their own consumption. The fisherwomen are engaged in the marketing of fish.



FRP boats operated in Zuari estuary



Non-motorised wooden boat

Motorised wooden boat

Gillnet fishery

Gillnet fishery represents the major fishery and contributes to 90% of the total fish production from Zuari estuary. Gillnets are operated from FRP and wooden boats with and without OBM. Gillnets of various mesh sizes ranging from 30-200 mm are used for fishing while the gillnets of 30-60 mm are used regularly. A total of 184 aquatic species comprising 145 finfish species (Pelagic-58, Demersal-87) and 39 shellfish species (17 crustacean species and 22 molluscan species) were collected during this survey (Table A2).

Species caught in gillnets of different mesh sizes in Zuari estuary

S. No.	Mesh size of gillnet	Species
1	30 mm	Mixed catch
2	36 mm	Mixed catch
3	40 mm	Mixed catch
4	46 mm	Mixed catch
5	52 mm	Mixed catch (large size)
6	60 mm	Mixed catch (large size)
7	120 mm	Crabs and catfishes
8	160 mm	Seabass and snappers
9	200 mm	Rays



Fish gillnet (36 mm)



Fish gillnet (40 mm)



Crab gillnet (120 mm)



Seabass gillnet (160 mm)



Ray gillnet (200 mm)



Gillnet catch sorting

Species composition (This includes catch composition analysis from 30-60 mm gillnets)

White sardine, *Escualosa thoracata*: this pelagic single species is found to be the major constituent of the fish catch in the mouth of Zuari estuary. It has contributed to 13.3% of the total abundance (numbers) of fish catch.

Penaeid shrimps: Penaeid shrimps contributed to about 9.7% of the total abundance (numbers) of fish catch. The major species caught in the estuary were *Fenneropenaeus indicus*, *Marsupenaeus japonicus*, *Metapenaeus affinis*, *M. brevicornis*, *M. dobsonii*, *M. monoceros* and *Parapenaeopsis stylifera*.

Silverbellies: They are the common demersal resources along the Zuari estuary. They have contributed about 9.5% of the total abundance (numbers) of fish catch. The major species caught were *Leiognathus brevirostris*, *L. blochii*, *L. bindus*, *L. dussumieri*, *L. splendens*, *L. daura*, *L. equulus* and *Secutor insidiator*.

Crabs: Crabs are found to be one of the major resources along the coastal region of Zuari mouth. They have contributed about 8.2% of the total abundance (numbers) of fish catch. The major species caught in the estuary were *Portunus pelagicus*, *P. sanguinolentus*, *Scylla serrata*, *S. tranquebarica*, *Charybdis lucifera* and *C. natator*.

Mullets: They are the most dominant typical estuarine species along the coastal regions. They have contributed about 8% of the total abundance (numbers) of fish catch. The major species caught were *Mugil cephalus*, *Valamugil cunnesius*, *Liza parsia*, *Liza tade* and *Liza macrolepis*.

Shads: They are one of the important pelagic resources available along the Zuari estuarine system. They have contributed about 7.4% of the total abundance (numbers) of fish catch. The major species caught were *Tenulosa toli*, *Ilisha filigera*, *I. megaloptera* and *I. melastoma*.

Moustached anchovies: They are also one of the common pelagic resources available along the Zuari estuarine system. They have contributed about 7% of the total abundance (numbers) of fish catch. The major species caught were *Thryssa malabarica*, *T. mystax*, *T. setirostris* and *T. hamiltonii*.

Carangids: They are also one of the diverse pelagic resources available along the Zuari estuarine system. They have contributed about 5.2% of the total abundance (numbers) of fish catch. The major species caught were *Alepes kleinii*, *A. kalla*, *S. commersonianus*, *Megalaspys cordyla*, *A. melanoptera*, *Atule mate*, *Trachinotus mookalee* and *Carangoides praeustus*.

Bony breams: They are one of the common pelagic resources along the mouth of the Zuari estuary. They have contributed about 4.3% of the total abundance (numbers) of fish catch. The major species caught were *Nematalosa nasus* and *Anodontostoma chacunda*.

Sardines: They are one of the common pelagic resources along the Zuari estuary. They have contributed about 3.7% of the total abundance (numbers) of fish catch. The major species caught were *S. longiceps*, *S. gibbosa* and *S. albella*.

Croakers: They are one of the important resident demersal resources along the Zuari estuary. They have contributed about 3.1% of the total abundance (numbers) of fish catch. The major species caught were *Johnius macrorhynchus*, *J. belangerii*, *J. dussumieri*, *Otolithes ruber*, *O. cuvieri*, *O. argenteus*, *Johnieops sina*, *J. borneensis*, *Dendrophysa russelli*, *Nibea albida* and *N. soldado*.

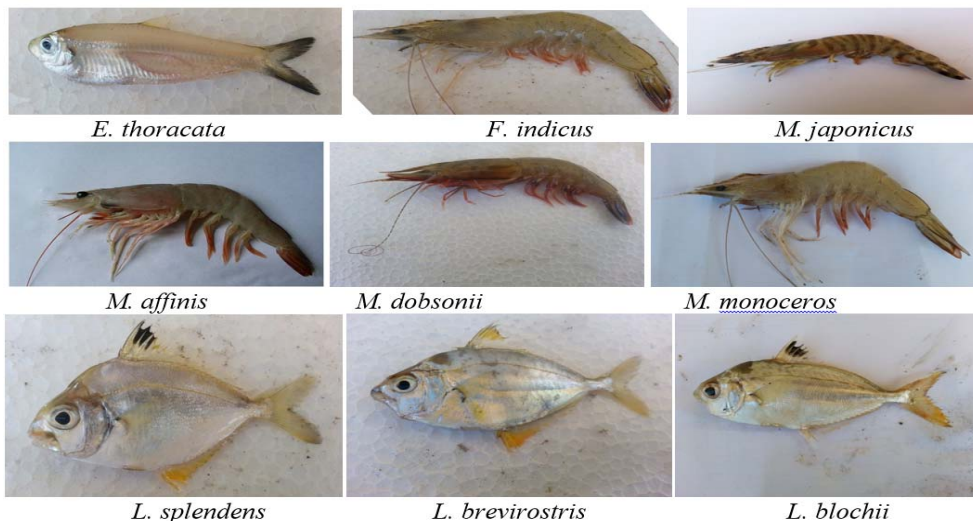
Indian mackerel, *Rastrelliger kanagurta*: This is one of the most important pelagic single species contribute to the fish catch from Zuari estuary. It contributes about 3.1% of the total abundance (numbers) of fish catch.

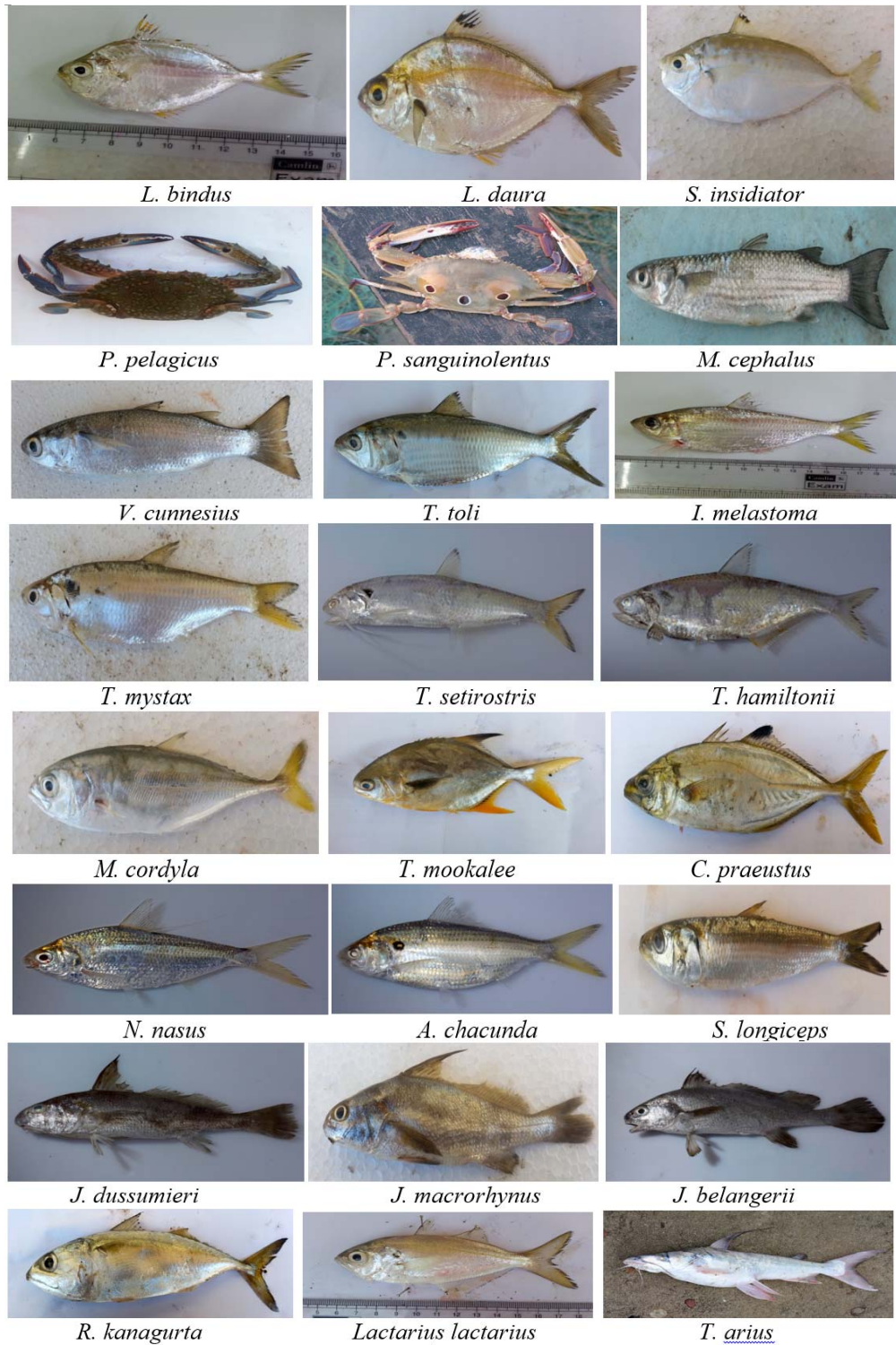
Whitebaits: They are one of the common pelagic resources along the Zuari estuary. They have contributed about 2.3% of the total abundance (numbers). The major species caught were *Stolephorus commersonii* and *S. indicus*.

Bigjawed jumper, *Lactarius lactarius*: It is one of the important single species demersal resources along the Zuari estuary. It contributes about 1.7% of the total abundance (numbers) of fish catch.

Catfishes: They are one of the common demersal resources along the Zuari estuary. They have contributed about 1.1% of the total abundance (numbers) of fish catch. The major species caught were *Arius platystomus*, *Tachysurus arius*, *A. caelatus*, *A. dussumieri*, *A. thalassinus* and *A. jella*.

Silverbiddies: They are one of the common demersal resources available all along the Zuari estuary. They have contributed about 1% of the total abundance (numbers) of fish catch. The major species caught were *Gerres filamentosus*, *G. setifer*, *G. oyena*, *G. limbatus* and *G. longirostris*.



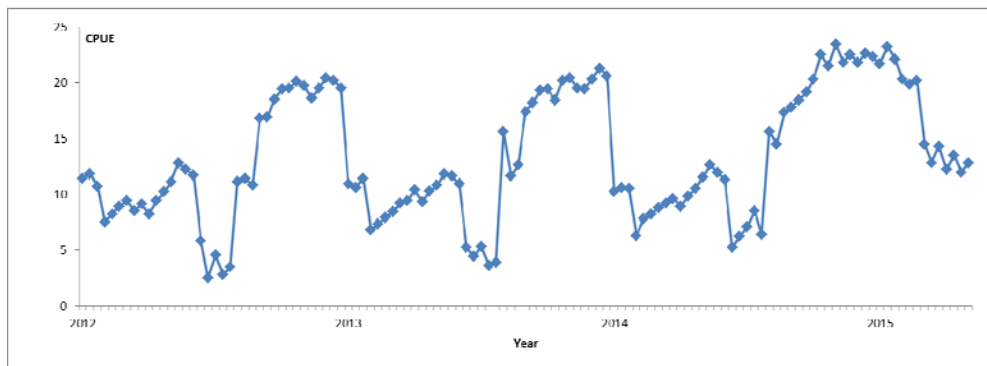


Fishes caught in gillnet fishery

Trend in fish catch in the estuary

The traditional fishermen catch per unit effort (CPUE in kg/hr) in gillnet fishery has followed a fluctuating trend during 2012 to 2015 (2012-2013 data collected from fishermen’s log book and fisheries department) with highest catches during the post-monsoon season (October to January) and lowest catches during pre-monsoon season (April and May). However, the catch rates have not declined seriously from 2012 to 2015. Moreover, there was an increase in catch rates since 2014. The increase in catch rates during this period may be attributed to

the reduction of illegal intrusion of mechanised fishing due to the continuous surveillance from patrol boat of fisheries department. The total fish catch in the estuary has also portrayed that the fish catches were high during post-monsoon season in comparison with the other seasons. In this estuary, the average annual fish catch during 2012-2015 was 1050.5 tonnes with highest and lowest values during post-monsoon (542.3 tonnes) and pre-monsoon (145 tonnes) seasons respectively. The average fish catch during monsoon season was 322.1 tonnes.



Source: Interview with key fishermen and the data collected during this study

The trend in CPUE during 2012-2015

Hook and line fishery

Hook and line fishery represent a minor fishery in Zuari estuary in which about 60-80 fishermen are involved. The contribution of this fishery is negligible in comparison with the gillnet fishery. However, this fishery deals with large sized specimens and unit value of catch is on the high. They use

different types of hooks for catching different species of fishes. The hook and line fishing is season specific and mostly carried out during the end of post-monsoon season and pre-monsoon season. A total number of 50 species support the hook and line fishery in Zuari estuary.

Species caught in hook line fishing

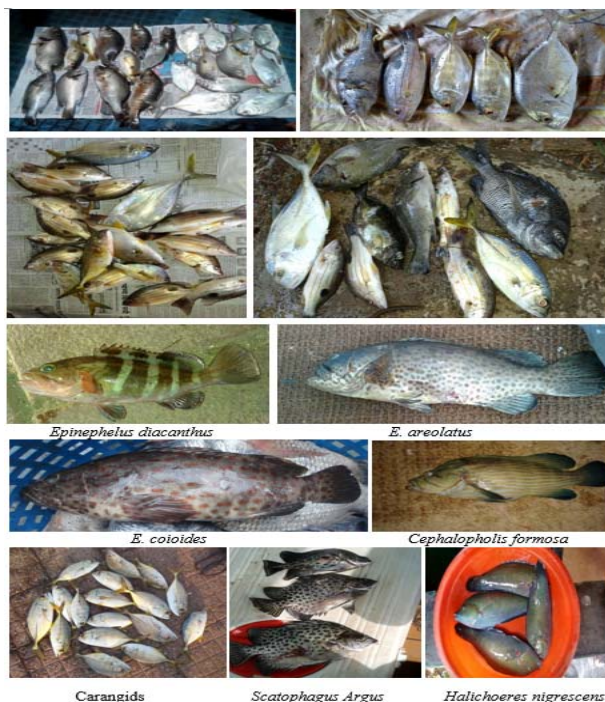
S. N.	Hook type	Fishes caught	Species
1	No. 13 and 15	Indian Whiting, rabbit fishes, wrasses, gobies, small groupers, scat	<i>Sillago sihama</i> , <i>Siganus canaliculatus</i> , <i>S. javus</i> , <i>S. vermiculatus</i> , <i>Halichoeres nigrescens</i> , <i>Istigobius diadema</i> , <i>Epinephelus diacanthus</i> , <i>Scatophagus argus</i>
2	No. 1 to 3	Seabass, snappers, groupers	<i>Lates calcarifer</i> , <i>Lutjanus argentimaculatus</i> , <i>L. johnii</i> , <i>L. rivulatus</i> , <i>L. indicus</i> , <i>L. fulvus</i> , <i>Epinephelus diacanthus</i> , <i>Epinephelus coioides</i> , <i>Cephalopholis formosa</i> ,
3	No. 4 to 6	Sea bream, snappers, mullets, carangids, seerfishes, polynemids	<i>Acanthopagrus latus</i> , <i>A. berda</i> , <i>Lutjanus argentimaculatus</i> , <i>L. johnii</i> , <i>L. rivulatus</i> , <i>L. indicus</i> , <i>L. fulvus</i> , <i>Mugil cephalus</i> , <i>Caranx sp.</i> , <i>Scomberomorus commerson</i> , <i>Eleutheronema tetradactylum</i>
4	No. 1/0 to 6/0	Snappers and Groupers (large sized)	<i>Lutjanus argentimaculatus</i> , <i>L. johnii</i> , <i>L. rivulatus</i> , <i>Epinephelus coioides</i>



Hooks of various dimensions



Multiple hooks for seabass



Fishes caught in hook and line fishing

Collection of mussels, oysters and sea slugs

The mussel, *Perna viridis* and oysters, *Crassostrea madrasensis* and *Saccostrea cuculata* are the important bivalves available in the estuary. They are concentrated on the rocky patches along the estuary. There are about 20-25 skin divers among fishermen who collect mussels and oysters in the pre-monsoon season. Due to the drastic decline in the production of mussels and oysters from the estuary, there is religious restriction in the collection of mussels during the spawning and growing stages (September to February). The spawning season for mussels is reported as from September to October. Thus, the collection of mussels and oysters starts in the Zuari estuary after the religious pooja offered to Goddess during February and the collection extend till the third week of May. The clams are collected throughout the year in the estuary. However, the sea slugs are collected from the rocky regions during post-monsoon and pre-monsoon seasons.

Information on collection of bivalves and sea slugs

S. N.	Species	Season of collection	Length range (Total length in cm)
1	Green mussel, <i>Perna viridis</i>	February to May	5.8-9.2
2	Indian backwater oyster, <i>Crassostrea madrasensis</i>	February to May	8.5-18.2
3	Sea slug, <i>Onchidium sp.</i>	October to April	4.5-8.5
4	Clams (<i>Paphia malabarica</i> , <i>Meretrix meretrix</i>)	Year round	3-6



Collection of bivalves in Zuari estuary

High diversity and species richness is a characteristic feature of sub-tropical and tropical estuaries of the Indo-Pacific region. The present information on fisheries profile of the Zuari estuary contributes additional knowledge for the estuaries and bays of the Indian coast. There should be immediate actions to protect the species rich coastal zones like the Zuari estuarine system.

Practical solutions for the management of fishery

Fisheries co-management

The development of a system of “co-management” can be a solution which will be based on the co-operation between fishing community, interested stake-holders, research institutions, NGOs and Government departments for the sustainability of Zuari estuary. In this system, village level traditional societies and boat owners groups will be the major stakeholders. This can be developed using pilot scale experimental systems of management under the Department of

fisheries and research institutions. However, the successful development of co-management system requires huge awareness and capacity building programmes to the fishing community and other stake-holders. Care should be also taken to include spatio-temporal resource and environmental patterns (biology, spawning, juvenile grounds and critical habitats) under the broad co-management regime. This system should also include the accurate reporting of fisheries data (mesh size used, area of fishing, total catch, catch rates, value of catch, size of fish species caught) directly from fishermen to fisheries department and research institutions. Moreover, the mesh size regulations for gillnet operations, closed seasons and areas for fishing as well as for collection of bivalves should be implemented. Strengthening of the religious restrictions for the collection of bivalves should be also included under the co-management framework.

The fisheries department of Goa has already initiated an active patrolling system to monitor the illegal and indiscriminate fishing operations in the coastal areas of Goa including the Zuari estuary. The fishermen of the estuary also monitor and inform the department once they come across the indiscriminate fishing operations. This has succeeded in regulating the entry of mechanized vessels into coastal waters and motorised/non-motorised boats into offshore areas. This system can be strengthened using coastal police surveillance and by including more patrol boats.

Enhancement techniques

About 80% of the fish production in Goa comes from coastal waters. Thus, there is an overexploitation in this region and it is high time to carry out biological resource enhancement activities such as the deployment of artificial reefs and sea ranching of commercially important species. An excellent artificial reef habitat can be established near shore areas for attachment of corals and fishes in different trophic level to popularize the eco-tourism as well as to enhance the fishery resources. This can be used by fishermen for fishing, students for education, scientists for research, tourists for snorkeling, SCUBA diving, sport fishing with angles (hooks & line), trap fishing for live ornamental fishes and recreational diving. Mouth of the Zuari estuary which opens into Arabian Sea holds suitable sites for the installation of small scale and small sized artificial fish habitats (rectangular, triangular and reef ball modules). This will help to augment the fishery resources in this region and contribute to the sustainable livelihood of fishermen in this estuary. This will also help to rehabilitate the aquatic species and fish stocks which might have disappeared due to degradation of habitats by environmental pollution and other anthropogenic factors.

There is a scope for brackish water finfish and shellfish culture in the estuary with the participation of fishermen community. The seeds of the fish and shellfish are available in the estuary. The small scale finfish cage culture and bivalve culture (rack, raft and tray methods) can be attempted to improve the fish production from the estuary. Thus, it can contribute to regulate the demand for fish in the state.

The sampling sites used in the present study are situated in the mouth of Zuari estuary which represents an important coastal ecosystem of Goa where major commercial gill net operations are carried out. The study may not have documented the complete species in the coastal region. Moreover, the study may not have addressed the complete fisheries profile of the study site. However, this study has definitely addressed the finfish and shellfish diversity profile upto an extent. Hence,

this will obviously remain as a strong reference point for ecosystems. future investigations in this region and other tropical coastal



Other species obtained from Zuari estuary

Table A1: List of Species obtained in the gillnet fishery in Zuari estuary

Group	Species	Family	Class	Group	Species	Family	Class
Barracudas	<i>Sphyraena jello</i>	Sphyraenidae	Pelagic	Groupers	<i>Epinephelus tauvina</i>	Serranidae	Demersal
Barracudas	<i>S. obtusata</i>	Sphyraenidae	Pelagic	Groupers	<i>Epinephelus coioides</i>	Serranidae	Demersal
Bony breams	<i>Anodontostoma chacunda</i>	Clupeidae	Pelagic	Grunts	<i>Plectorhinchus gibbosus</i>	Haemulidae	Demersal
Bony breams	<i>Nematalosa nasus</i>	Clupeidae	Pelagic	Grunts	<i>P. chubbi</i>	Haemulidae	Demersal
Carangids	<i>Alepes kleinii</i>	Carangidae	Pelagic	Lizardfish	<i>Saurida tumbil</i>	Synodontidae	Demersal
Carangids	<i>A. melanoptera</i>	Carangidae	Pelagic	Wrasse	<i>Halichoeres nigrescens</i>	Labridae	Demersal
Carangids	<i>A. kalla</i>	Carangidae	Pelagic	Bannerfish	<i>Heniochus acuminatus</i>	Chaetodontidae	Demersal
Carangids	<i>Atule mate</i>	Carangidae	Pelagic	Pufferfishes	<i>Lagocephalus wheeleri</i>	Tetraodontidae	Demersal
Carangids	<i>Carangoides praeustus</i>	Carangidae	Pelagic	Pufferfishes	<i>L. inermis</i>	Tetraodontidae	Demersal
Carangids	<i>Scomberoides lysan</i>	Carangidae	Pelagic	Pufferfishes	<i>Tetraodon fluviatilis</i>	Tetraodontidae	Demersal
Carangids	<i>S. tol</i>	Carangidae	Pelagic	Silverbellies	<i>Leiognathus dussumieri</i>	Leiognathidae	Demersal
Carangids	<i>S. commersonianus</i>	Carangidae	Pelagic	Silverbellies	<i>L. bindus</i>	Leiognathidae	Demersal
Carangids	<i>Trachinotus mookalee</i>	Carangidae	Pelagic	Silverbellies	<i>L. brevirostris</i>	Leiognathidae	Demersal
Carangids	<i>Alectis ciliaris</i>	Carangidae	Pelagic	Silverbellies	<i>L. blochii</i>	Leiognathidae	Demersal
Carangids	<i>A. indicus</i>	Carangidae	Pelagic	Silverbellies	<i>L. equulus</i>	Leiognathidae	Demersal
Carangids	<i>Gnathanodon speciosus</i>	Carangidae	Pelagic	Silverbellies	<i>L. splendens</i>	Leiognathidae	Demersal
Full beaks	<i>Strongylura strongylura</i>	Belonidae	Pelagic	Silverbellies	<i>L. daura</i>	Leiognathidae	Demersal
Golden anchovies	<i>Coilia dussumieri</i>	Engraulidae	Pelagic	Silverbellies	<i>Secutor insidiator</i>	Leiognathidae	Demersal
Halfbeaks	<i>Hyporhamphus dussumieri</i>	Hemiramphidae	Pelagic	Silverbiddies	<i>Gerres filamentosus</i>	Gerreidae	Demersal
Halfbeaks	<i>H. limbatus</i>	Hemiramphidae	Pelagic	Silverbiddies	<i>G. setifer</i>	Gerreidae	Demersal
Halfbeaks	<i>Hemiramphus lutkei</i>	Hemiramphidae	Pelagic	Silverbiddies	<i>G. longirostris</i>	Gerreidae	Demersal
Horse mackerel	<i>Megalaspys cordyla</i>	Carangidae	Pelagic	Silverbiddies	<i>G. oyena</i>	Gerreidae	Demersal
Mackerel	<i>Rastrelliger kanagurta</i>	Scombridae	Pelagic	Silverbiddies	<i>G. limbatus</i>	Gerreidae	Demersal
Glassy perchlets	<i>Ambassis commersonii</i>	Ambassidae	Pelagic	Snappers	<i>Lutjanus johni</i>	Lutjanidae	Demersal
Glassy perchlets	<i>Ambassis urotaenia</i>	Ambassidae	Pelagic	Snappers	<i>L. indicus</i>	Lutjanidae	Demersal
Glassy perchlets	<i>A. gymnocephalus</i>	Ambassidae	Pelagic	Snappers	<i>L. argentimaculatus</i>	Lutjanidae	Demersal
White pomfret	<i>Pampus argenteus</i>	Stromateidae	Pelagic	Asian seabass	<i>Lates calcarifer</i>	Latidae	Demersal
Moustached anchovies	<i>Thryssa malabarica</i>	Engraulidae	Pelagic	Rabbitfishes	<i>Siganus canaliculatus</i>	Siganidae	Demersal
Moustached anchovies	<i>T. mystax</i>	Engraulidae	Pelagic	Soles	<i>Euryglossa orientalis</i>	Soleidae	Demersal
Moustached anchovies	<i>T. setirostris</i>	Engraulidae	Pelagic	Soles	<i>Solea sp.</i>	Soleidae	Demersal
Moustached anchovies	<i>T. hamiltonii</i>	Engraulidae	Pelagic	Soles	<i>Synaptura commersonii</i>	Soleidae	Demersal
Mullets	<i>Liza macrolepis</i>	Mugilidae	Pelagic	Soles	<i>Pseudorhombus triocellatus</i>	Paralichthyidae	Demersal
Mullets	<i>L. parsia</i>	Mugilidae	Pelagic	Soles	<i>P. arsius</i>	Paralichthyidae	Demersal
Mullets	<i>L. tade</i>	Mugilidae	Pelagic	Threadfins	<i>Polynemus heptadactylus</i>	Polynemidae	Demersal
Mullets	<i>Mugil cephalus</i>	Mugilidae	Pelagic	Threadfins	<i>Eleutheronema tetradactylum</i>	Polynemidae	Demersal
Mullets	<i>Valamugil cunnesius</i>	Mugilidae	Pelagic	Tiger perches	<i>Terapon jarbua</i>	Terapontidae	Demersal
White sardine	<i>Escualosa thoracata</i>	Clupeidae	Pelagic	Tiger perches	<i>T. theraps</i>	Terapontidae	Demersal
Long finned herring	<i>Opisthopterus tardoore</i>	Pristigasteridae	Pelagic	Tiger perches	<i>T. Puta</i>	Terapontidae	Demersal
Rainbow sardine	<i>Dussumieria acuta</i>	Dussumieriidae	Pelagic	Tiger perches	<i>Pelates quadrilineatus</i>	Terapontidae	Demersal

Sand whiting	<i>Sillago sihama</i>	Sillaginidae	Pelagic	Tongue soles	<i>Cynoglossus macrolepidotus</i>	Cynoglossidae	Demersal
Sardines	<i>Sardinella albella</i>	Clupeidae	Pelagic	Tongue soles	<i>C. macrostomus</i>	Cynoglossidae	Demersal
Sardines	<i>S. gibbosa</i>	Clupeidae	Pelagic	Tongue soles	<i>C. dispar</i>	Cynoglossidae	Demersal
Sardines	<i>S. longiceps</i>	Clupeidae	Pelagic	Tongue soles	<i>C. puncticeps</i>	Cynoglossidae	Demersal
Scat	<i>Scatophagus argus</i>	Scatophagidae	Pelagic	Tongue soles	<i>Paraplagusia bilineata</i>	Cynoglossidae	Demersal
Shads	<i>Ilisha filigera</i>	Pristigasteridae	Pelagic	Gobies	<i>Trypauchen vaginalis</i>	Gobiidae	Demersal
Shads	<i>I. megaloptera</i>	Pristigasteridae	Pelagic	Gobies	<i>Acentrogobius nebulosus</i>	Gobiidae	Demersal
Shads	<i>I. melastoma</i>	Pristigasteridae	Pelagic	Gobies	<i>Istigobius diadema</i>	Gobiidae	Demersal
Shads	<i>Tenualosa toli</i>	Clupeidae	Pelagic	Rays	<i>Himantura uarnak</i>	Dasyatidae	Demersal
Shads	<i>Pellona sp.</i>	Pristigasteridae	Pelagic	Rays	<i>H. imbricata</i>	Dasyatidae	Demersal
Whitebaits	<i>Encrasicholina devisi</i>	Engraulidae	Pelagic	Rays	<i>H. fluviatilis</i>	Dasyatidae	Demersal
Whitebaits	<i>Stolephorus commersonii</i>	Engraulidae	Pelagic	Rays	<i>Aetobates narinari</i>	Myliobatidae	Demersal
Whitebaits	<i>S. indicus</i>	Engraulidae	Pelagic	Toad fishes	<i>Amphichthys cryptocentrus</i>	Batrachoididae	Demersal
Ribbonfishes	<i>Trichiurus lepturus</i>	Trichiuridae	Pelagic	Tripod fishes	<i>Triacanthus brevirostris</i>	Triacanthidae	Demersal
Ribbonfishes	<i>Lepturacanthus savala</i>	Trichiuridae	Pelagic	Crabs	<i>Charybdis lucifera</i>	Portunidae	Crustacean
Seerfishes	<i>Scomberomorus commerson</i>	Scombridae	Pelagic	Crabs	<i>Charybdis feriatus</i>	Portunidae	Crustacean
Seerfishes	<i>S. guttatus</i>	Scombridae	Pelagic	Crabs	<i>C. natator</i>	Portunidae	Crustacean
Tenpounder	<i>Elops machnata</i>	Elopidae	Pelagic	Crabs	<i>Portunus sanguinolentus</i>	Portunidae	Crustacean
Tarpon	<i>Megalops cyprinoides</i>	Megalopidae	Pelagic	Crabs	<i>P. pelagicus</i>	Portunidae	Crustacean
Bamboo sharks	<i>Chilloscyllum griseum</i>	Hemiscyllidae	Demersal	Crabs	<i>Scylla serrata</i>	Portunidae	Crustacean
Big Jawed Jumper	<i>Lactarius lactarius</i>	Lactariidae	Demersal	Crabs	<i>S. tranquebarica</i>	Portunidae	Crustacean
Breams	<i>Acanthopagrus berda</i>	Sparidae	Demersal	Crabs	<i>Matuta lunaris</i>	Matutidae	Crustacean
Catfishes	<i>Arius arius</i>	Ariidae	Demersal	Penaeid shrimps	<i>Fenneropenaeus indicus</i>	Penaeidae	Crustacean
Catfishes	<i>A. caelatus</i>	Ariidae	Demersal	Penaeid shrimps	<i>Marsupenaeus japonicus</i>	Penaeidae	Crustacean
Catfishes	<i>A. dussumieri</i>	Ariidae	Demersal	Penaeid shrimps	<i>Metapenaeus affinis</i>	Penaeidae	Crustacean
Catfishes	<i>A. jella</i>	Ariidae	Demersal	Penaeid shrimps	<i>M. brevicornis</i>	Penaeidae	Crustacean
Catfishes	<i>A. platystomus</i>	Ariidae	Demersal	Penaeid shrimps	<i>M. dobsonii</i>	Penaeidae	Crustacean
Catfishes	<i>A. subrostratus</i>	Ariidae	Demersal	Penaeid shrimps	<i>M. monoceros</i>	Penaeidae	Crustacean
Catfishes	<i>A. thalassinus</i>	Ariidae	Demersal	Penaeid shrimps	<i>Parapenaeopsis stylifera</i>	Penaeidae	Crustacean
Catfishes	<i>A. venosus</i>	Ariidae	Demersal	Stomatopods	<i>Lysiosquilla sp</i>	Squillidae	Crustacean
Catfishes	<i>A. maculatus</i>	Ariidae	Demersal	Stomatopods	<i>Oratosquilla nepa</i>	Squillidae	Crustacean
Croakers	<i>Dendrophysa russelli</i>	Sciaenidae	Demersal	Cephalopods	<i>Loligo duvaucelli</i>	Loliginidae	Molluscan
Croakers	<i>Johnieops borneensis</i>	Sciaenidae	Demersal	Cephalopods	<i>Loliolus investigatoris</i>	Loliginidae	Molluscan
Croakers	<i>Johnieops sina</i>	Sciaenidae	Demersal	Cephalopods	<i>Sepiella inermis</i>	Sepiidae	Molluscan
Croakers	<i>Johnius macrorhynchus</i>	Sciaenidae	Demersal	Cephalopods	<i>Octopus dofusii</i>	Octopodidae	Molluscan
Croakers	<i>Johnius macropterus</i>	Sciaenidae	Demersal	Gastropods	<i>Bursa sp.</i>	Bursidae	Molluscan
Croakers	<i>J. belangerii</i>	Sciaenidae	Demersal	Gastropods	<i>Hemifusus pugilinus</i>	Melongenidae	Molluscan
Croakers	<i>J. dussumieri</i>	Sciaenidae	Demersal	Gastropods	<i>Tibia curta</i>	Rostellariidae	Molluscan
Croakers	<i>Nibeia albida</i>	Sciaenidae	Demersal	Gastropods	<i>Telescopium</i>	Potamididae	Molluscan
Croakers	<i>N. soldado</i>	Sciaenidae	Demersal	Gastropods	<i>Natica sp.</i>	Naticidae	Molluscan
Croakers	<i>N. sp.</i>	Sciaenidae	Demersal	Gastropods	<i>Trochus radiatus</i>	Trochidae	Molluscan
Croakers	<i>Otolithes ruber</i>	Sciaenidae	Demersal	Gastropods	<i>Babylonia spirata</i>	Babyloniidae	Molluscan
Croakers	<i>O. cuvieri</i>	Sciaenidae	Demersal	Bivalves	<i>Placuna placenta</i>	Placunidae	Molluscan
Croakers	<i>O. argenteus</i>	Sciaenidae	Demersal	Bivalves	<i>Paphia malabarica</i>	Veneridae	Molluscan
Croakers	<i>Paranibeia semiluctosa</i>	Sciaenidae	Demersal	Bivalves	<i>Paphia textile</i>	Veneridae	Molluscan
Eels	<i>Congresox talabon</i>	Muraenesocidae	Demersal	Bivalves	<i>Villorita cyprinoides</i>	Corbiculidae	Molluscan
Eels	<i>Muraenesox bagio</i>	Muraenesocidae	Demersal	Bivalves	<i>Perna viridis</i>	Mytilidae	Molluscan
Eels	<i>M. cinereus</i>	Muraenesocidae	Demersal	Bivalves	<i>Crassostera madrasensis</i>	Ostreidae	Molluscan
Drift fishes	<i>Drepane</i>	Drepanidae	Demersal	Bivalves	<i>Saccostrea cuculata</i>	Ostreidae	Molluscan

	<i>punctata</i>						
Drift fishes	<i>Drepane longimana</i>	Drepanidae	Demersal	Bivalves	<i>Meretrix metretrix</i>	Veneridae	Molluscan
Flatheads	<i>Rogadius pristiger</i>	Platycephalidae	Demersal	Bivalves	<i>Meretrix casta</i>	Veneridae	Molluscan
Flatheads	<i>Platycephalus indicus</i>	Platycephalidae	Demersal	Bivalves	<i>Donax variabilis</i>	Donacidae	Molluscan
Groupers	<i>Epinephelus diacanthus</i>	Serranidae	Demersal	Bivalves	<i>Marcia opima</i>	Veneridae	Molluscan

References

1. Ansari ZA, Chatterji A, Ingole BS, Sreepada RA, Rivonkar CU, Parulekar AH. Community Structure and seasonal Variation of an Inshore Demersal Fish Community at Goa, West Coast of India. *Estuarine, Coastal and Shelf Science*, 1995; 41:593-610.
2. George G, Desai DV, Gaonkar CA, Aboobacker VM, Vethamony P, Anil AC. Barnacle larval transport in the Mandovi- Zuari estuarine system, central west coast of India. *Journal of Oceanography*, 2013; 69(4):451-466.
3. Krishna Kumari L, Bhattathiri PMA, Matondkar SGP, John J. Primary productivity in Mandovi-Zuari estuaries in Goa. *Journal of Marine Biological Association of India*, 2002; 44(1&2):1-13.
4. Qasim SZ. Productivity of backwaters and estuaries. *IBP Ecological Studies*, 1973; 3:143-154.
5. Qasim SZ, Sen Gupta R. Environmental Characteristics of the Mandovi-Zuari Estuarine System in Goa. *Estuarine, Coastal and Shelf Science*, 1981, 13:557-578.
6. Shetye SR, Dileep Kumar M, Shankar D. Mandovi and Zuari estuaries. *National Institute of Oceanography, Goa, India*, 2007; 157.
7. Shirodkar PV, Deepthi M, Vethamony P, Mesquita AM, Pradhan UK, Babu MT, Verlecar XN, Haldankar SR. Tide dependent seasonal changes in water quality and assimilative capacity of anthropogenically influenced Mormugao harbour water. *Indian Journal of Geo-Marine Sciences*, 2012; 41(4):314-330.
8. Sreekanth GB, Manju Lekshmi N, Singh NP. Temporal patterns in fish community structure; environmental perturbations in a well-mixed tropical estuary. *PNAS-SEC-B Biological Sciences*. 2015. DOI: 10.1007/s40011-015-0581-2.
9. Sreekanth GB, Manju Lekshmi N, and Singh NP. Catch Trends in Major Marine Fisheries Resources of Goa, Technical Bulletin No: 49, ICAR Research Complex for Goa (Indian Council of Agricultural Research), Goa, India, 2015; 42.
10. Subramanian S, Sreekanth GB, Manjulekshmi N, Singh NP, Janhavi K, Tejaswini P, Pastta MF. Manual on The Use of Potential Fishing Zone (PFZ) forecast. Technical bulletin No. 40, ICAR Research Complex for Goa (Indian Council of Agricultural Research), Goa, India, 2014; 27.